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(71) Applicants and
(72) Inventors: **OLIVEIRA, Manuel** [PT/GB]; Flat 3, 3 Park Drive, Golders Green, London, Greater London NW11 7SG (GB). **SLATER, Mel** [GB/GB]; Flat 8, 146 Wapping High St, London, Greater London E1W 3PE (GB). **CROWCROFT, Jon** [GB/GB]; University of Cambridge, William Gates Building, J J Thomson Avenue, Cambridge, Cambridgeshire CB3 0FD (GB).

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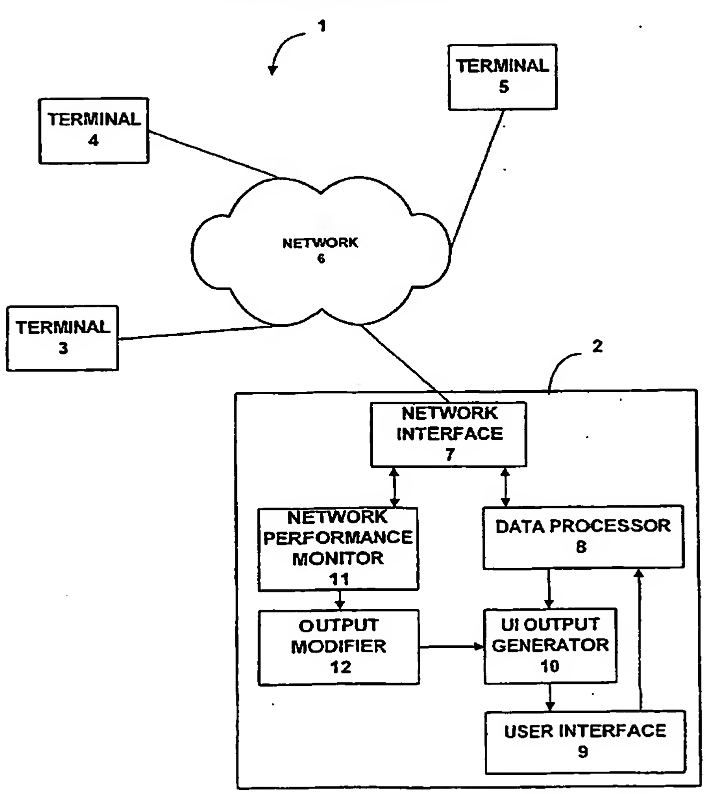
(54) Title: NETWORK PERFORMANCE INDICATORS

COLLABORATIVE SYSTEM



(57) Abstract: In a set of local terminals (2-5) communicating via a network (6) to constitute a collaborative system (1), each terminal (2) receives data via the network and processes the data to present information via a user interface (9). A network performance monitor (11) determines a network performance parameter representative of performance status of the network in facilitating collaborative communication between the terminals. The network performance monitor outputs the network performance parameter to an output modifier (12) which controls the output generated by a user interface output generator (10) such that the information presented by the user interface to the user is varied according to the value of the network performance parameter for facilitating user perception of the performance status of the network. Where a scene is presented to the viewer, a perceptual metaphor may thereby be conveyed such as to associate fine sunny weather conditions with a good state of well-being of the network and to associate rainy or wintery conditions with a deteriorating state of well-being of the network. The process has application to virtual reality environments allowing interaction between virtual characters controlled by participants each provided with a respected one of the terminals at remote locations served by the network, as in the case of Internet based games.

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NETWORK PERFORMANCE INDICATORS

This invention relates to collaborative processes in which a group of terminals connected by a network operate in a manner which allows real time interaction between users of the terminals. The process may for example be one in which a virtual reality environment is created to allow interaction between virtual characters controlled by participants each provided with a respective terminal at mutually remote locations served by the network. Such an environment may be used to play a game, as a training and, as a means of communication or as part of a control system. Other examples include audio, video or audio-visual conferencing facilities in which participants are provided with audio-visual data streams from other participants in a communications session via networks such as the Internet, cellular mobile communications network, cable networks, telephone networks, or combinations thereof.

The performance of networks such as the Internet used for such collaborative processes tends to vary according to prevailing conditions. For example, the time taken for data to traverse the network between a local terminal and a remote terminal will depend not only on the direction

of propagation but on the current network conditions specifically affecting routes connecting these terminals. Other variables affecting quality of service of a network include the frequency with which packets of information are lost and need to be retransmitted and the overall throughput or rate of data traffic which is possible under prevailing conditions of network congestion.

At each terminal, the user is provided with a user interface allowing the user to participate for example by receiving a display which is generated to represent information obtained by processing data received via the network. The behaviour of the collaborative system as perceived by the user should ideally be consistent. However, under conditions where network quality of service deteriorates, the user may be presented with unexpected artifacts in the manner in which information is presented, thereby detracting from the ease with which the user may operate the terminal for interactive collaboration with the group.

An aspect of the present invention provides a method of processing information in the terminal which allows the output provided to the user to be controlled or modified in a manner which is representative of at least one

aspect of network performance. In one embodiment, the user interface provides a display screen representing a scene representing a virtual environment and a measured network performance parameter is used as a control signal for controlling the manner in which the scene is rendered. A change in network quality is therefore accompanied by a modification in the manner in which the scene is rendered, the resulting modification being recognisable by the user so that the user is then able to modify the way in which the user interacts with the system via the user interface. For example, if the scene is represented in a way which suggests to the user that communication with one of the entities of the collaborative group is subject to excessive latency, the user will allow additional time for that entity to react to any action taken by the user.

In the case of a scene which is synthesised, as in the case of a virtual environment, it may be appropriate to use a perceptual metaphor within the scene in order to convey to the viewer the state of well being of the network. One such perceptual metaphor is to associate fine, sunny weather conditions with a good state of well being and to associate rainy, stormy or wintery conditions with a deteriorating state of well being.

Another metaphor is to associate a bright sunny well lit scene with a good state of well being and to associate progressively darker and gloomier, poorly lit scenes with progressively deteriorating states of well being.

In the case of a scene which is not synthesised but which is derived from a video stream obtained from a video camera of an actual subject, it may be appropriate to control the scene to represent a measured network performance parameter by varying the quality of reproduction of the video image, for example by allowing controlled break up of the image, slowing the rate at which the scene is refreshed, reducing the size of the image or partially obscuring part of the image as in a tunnel vision effect. These effects may of course also be applied to synthesised images if desired and may additionally be viewed as perceptual metaphors when used in an appropriate context.

Embodiments of the invention will now be described by way of example only and with reference to the accompanying drawings of which:

Figure 1 is a schematic diagram of a collaborative system comprising a group of terminals connected by a network;

Figures 2A to 2L illustrate examples of modifications to a scene to represent network conditions;

Figure 3 is a schematic diagram showing greater detail of the network performance monitor and output modifier of the terminal of Figure 1;

Figures 4A to 4G are schematic diagrams of messages used in measuring network performance;

Figure 5 is a schematic diagram illustrating operation of an actuator;

Figure 6 is a schematic diagram illustrating hardware of the terminal of Figure 1; and

Figure 7 is a representation of a method of evaluating network performance and presenting information to the user.

Figure 1 illustrates a collaborative system 1 in which terminals 2, 3, 4 and 5 are connected by a network 6. In this example, terminal 2 will be referred to as a local terminal and will be described in detail, it being understood that each of the remaining remote terminals

3, 4 and 5 has a corresponding structure and mode of operation.

In this example, the network 6 consists of the Internet and the collaborative system 1 provides a distributed virtual environment in which the database for creating the virtual environment is distributed amongst the terminals 2, 3, 4 and 5. Users at each of the terminals 2, 3, 4 and 5 control respective virtual characters which are represented in scenes for viewing the virtual environment in real time.

In Figure 1, detail of the local terminal 2 includes a network interface 7 allowing two way communication with the network 6 and a data processor 8 which processes data received via the network and via a user interface 9 to obtain information relating to the current state of a model of the virtual environment. A user interface output generator 10 provides an output to the user interface 9 for displaying the information as a scene representing the virtual environment as viewed by the character controlled by the local terminal 2.

A network performance monitor 11 interacts with the remote terminals 3, 4 and 5 via the network 6 to obtain

information on the status of the network, including the network conditions specifically affecting the manner in which each of the remote terminals is currently able to interact with the local terminal 2.

The network performance monitor 11 provides an output modifier 12 with values of network performance parameters representing the network performance quality of service and the output modifier interacts with the user interface output generator 10 to control the output provided to the user interface 9 in a manner which is representative of the network performance parameters.

Figure 2A illustrates schematically a display provided by user interface 9 representing three characters in a virtual environment under normal network conditions, the term "normal" here being used to signify a high quality of network service provided by network 6. A first character 20, represented as a triangle, is controlled by terminal 3 such that movement and actions made by the character follow instructions input via the user of terminal 3 and communicated as data via the network 6 to the remaining terminals 2, 4 and 5. In terminal 2, the data is processed in data processor 8 and the character synthesised as part of graphics data representing a

scene. The user interface output generator 10 receives the graphics data and generates signals for input to the user interface 9 which includes an audio visual display apparatus.

Also shown in Figure 2A are a second character 21 represented as a circle and controlled by the user of terminal 4 and a third character 22, represented as a square, which in the virtual environment is controlled by the user of terminal 5.

If as an example the network conditions specifically affecting communication with terminal 3 become degraded such that data communicated between terminal 3 and the local terminal 2 becomes subject to delay or loss, or a combination thereof, to an extent which is likely to produce unexpected results or artifacts in the display output of the user interface 9, the deterioration in network performance is detected by network performance monitor 11, enabling output modifier 12 to interact with the user interface output generator 10 in a manner which allows the reduced network performance to be indicated to the user.

Since in this example the degradation in network 6 is

perceived by the local terminal 2 as being associated specifically with the network environment affecting terminal 3, it is appropriate to modify the manner in which the first character 20 is represented, without changing the manner in which the second and third characters 21 and 22 are represented to the user.

Figure 2B illustrates one example of how such representation may be effected. In Figure 2B, a breakup technique is used to fragment the displayed representation of the first character 20 which is now represented as fragmented character 23. For example, breakup can be achieved by fragmenting the visual representation of a figure into a number of separate pieces. The user will identify this breakup in terms of understanding that the behaviour of the first character 20 should be expected to change because of difficulties in communicating data with the remote terminal 3, thereby enabling the behaviour of the user to be adapted to the prevailing pattern of response. The user may for example choose to take actions which interact with only the second and third characters 21 and 22 for so long as the first character 20 is represented by fragmented characteb 23. Once the networks status associated with terminal 3 improves, detection of this improvement by the network

performance monitor 11 may result in the first character 20 being restored to its unbroken status as shown in Figure 2A, following which the user can adapt his behaviour accordingly.

The user may alternatively choose to continue to interact with the first character but will understand that while the fragmented character 23 is represented in the display, the response time associated with interactive behaviour will be degraded.

In this manner the virtual reality environment may be made more user friendly since the user is able to perceive prevailing network conditions.

Figure 2C illustrates an alternative representation for the example where the network conditions associated with remote terminal 3 are degraded such that the behaviour of the first character 20 is adversely affected. In this example, a probabilistic representation is used in which ghost images 24 and 25 are superimposed on the display at positions calculated to be possible positions of the first character 20. Where for example the first character 20 under normal network conditions is moving across the scene and subsequently the network conditions

affecting communication with terminal 3 are degraded, it may be possible for the virtual environment model to predict further movement in the absence of incoming data based on previous behavioural patterns. Where a number of options are available for predicted movement, a different ghost image 24, 25 may thereby be generated to represent each of the possible options. Once the network conditions improve and data representing the control signals input by the user of terminal 3 are processed by the data processor 8, the normal representation of Figure 2A may be resumed so that the ghost images disappear and the current intended position of the first character 20 is represented to the user.

The probabilistic representation of Figure 2C enables the user of terminal 2 to appreciate the degree of uncertainty associated with the intended position of the first character 20 in the virtual environment and enables the user to take appropriate action. In the absence of such a representation, the user could be presented with sudden unexplained erratic movement of the first character 20 following interruption and restoration of data communication via the network 6. The effect of the network performance monitor 11 and output modifier 12 is therefore to improve the user's understanding and

appreciation of the way in which the characters of the virtual environment are being controlled and to enable the user to perceive network quality of service and its effects.

In a further example, the network conditions affecting communication with the local terminal 2 are adversely affected so that all data communication from remaining terminals 3, 4 and 5 in the collaborative group are adversely affected in equal amount. Such degraded network conditions could be represented using the techniques of Figure 2B and 2C for example, applying the output modifier 12 to each of the 1st, 2nd and 3rd characters. Alternatively, a different representation indicating a global deterioration in network quality may be utilised, the term "global" being here used to signify that the effect is common to data communications with all other terminals of the collaborative group, typically arising from a degradation in network conditions localised to the local terminal 2.

Figure 2D illustrates one example of how the existence of global network deterioration may be represented to the user. In this example, the weather prevailing in the virtual environment is modified to provide a perceptual

metaphor of the prevailing network conditions. Since the user will associate fine sunny weather with good prevailing conditions and rain or snow with adverse conditions, it is appropriate to represent adverse network conditions by precipitation in the scene representing the virtual environment. In Figure 2D, the first, second and third characters 20, 21 and 22 are observed through a rain pattern 26. The intensity of the rain pattern 26 may be varied to represent different degrees of adverse network conditions. The use of weather control in the virtual environment is an example of a perceptual metaphor which relies upon the user's intuitive perception of adverse weather as an ominous portent in the virtual environment.

The rain pattern 26 may be generated by the user interface output generator 10 in response to a command from the output modifier 12 by applying a predetermined pattern to overlay the scene currently rendered as output to the user.

In an alternative example in Figure 2E, the prevailing light intensity is varied as a perceptual metaphor representative of network conditions. Since the user will associate bright, sunny conditions with a conducive

environment, the overall light intensity level can be progressively darkened to metaphorically represent various degrees of adverse network conditions. Such darkening of the scene is intuitively perceived by the user as metaphorically signifying a degradation of network performance, allowing the user to adapt the manner in which he interacts with the virtual environment system accordingly.

Figure 2E is therefore a further example of a representation of adverse global network conditions. It may be appropriate additionally to indicate network conditions associated with individual entities of the collaborative group, as previously discussed in relation to Figures 2B and 2C. Figure 2F is an example of representing global network conditions by reduced light level in combination with using the break up technique of Figure 2B to represent adverse network conditions which additionally specifically affect remote terminal 3.

Other forms of representation of global network conditions include the example of Figure 2G, 2H and 2I. Figure 2G represents a marginal deterioration in global network conditions by a tunnel effect, labelled

"TUNNEL 1" in Figure 2G, in which a marginal region 27 overlays the scene generated in the user interface output generator 10 to create a tunnel vision effect. A greater degree of network deterioration is signified by the "TUNNEL 2" of Figure 2H in which a larger marginal region 28 obscures the periphery of the scene. Finally, in the "TUNNEL 3" of Figure 2I, an even larger marginal region 29 obscures the periphery of the scene. The output modifier 12 commands the user interface output generator 10 to apply TUNNEL 1, 2 or 3 effects according to the measure of network performance detected by the networks performance monitor 11.

The degree of tunnel effect is appreciated intuitively by the user of terminal 2 as signifying progressive slowing or interruption of the processing underlying the virtual environment represented in the scene and therefore constitutes a further example of a perceptual metaphor.

Similarly, Figures 2J, 2K and 2L illustrate a further example in which the magnification applied to the rendered scene is varied to provide progressively decreasing magnifications 1, 2 and 3 respectively corresponding to progressively deteriorating global

network conditions.

Figure 3 illustrates schematically an embodiment of the network performance monitor 11 for use in the collaborative system 1 of Figure 1. The network performance monitor 11 interacts with the network 6 via the network interface 7 using probe messages to derive information used to update a number of entity state models 30, each of which constitutes a model of network conditions prevailing at a respective one of the terminals 3, 4 and 5, each of which being regarded as a separate entity requiring a separate model. In the example of Figure 3, three entity state models 30a, 30b and 30c are illustrated. The number of entity state models is however variable according to the number of entities which need to be modelled and may for example vary within a given session as one or more terminals joins or leaves the collaborative group.

Respective outputs from each of the entity state models 30 are provided to the output modifier 12 and provide the required data to enable the output modifier to interact with the user interface output generator 10 to modify the display as appropriate to prevailing network conditions, as described above in Figure 2.

The entity state models 30 also interact with a global state model 31 which models the overall network conditions as perceived by the local terminal 2. In this way, the onset of network deterioration common to all remote entities can be interpreted as being a global effect specifically associated with the local terminal. An output from the global state model 31 to the output modifier 12 allows the output modifier to interact with the user interface output generator 10 to create global effects on the display as illustrated above for example in Figures 2D to 2L.

The entity state models 30 exist as software modules controlled by a manager 32 which keeps track of the number of collaborative entities in the collaborative system 1 and creates or destroys entity state models accordingly. New entity state models 30 are created by a generator 33. The output modifier 12 similarly comprises a series of modules 12a, 12b and 12c in respect each one of the entity state models 30, these modules being similarly managed by the manager 32, the output modifier 12 also including a global module 12_G for receiving signals from the global state model 31.

A status provider 34 analyses information obtained from

probe messages received via the network interface 7 and inputs appropriate data to the entity state models 30.

A probe generator 35 generates outgoing probe messages using a multicast communications protocol to send messages to each entity of the collaborative group, in this case the terminals 3, 4 and 5. As illustrated in Figure 3, the status provider 34 is provided with a loss detector 36 specifically for keeping track of packet loss in each direction.

Each of the terminals 3, 4 and 5 similarly outputs probe messages for obtaining network status information. Local terminal 2 receives such probe messages and replies using responder 37.

The probe messages broadcast by local terminal 2 are therefore subject to similar reception and response by corresponding features of the terminals 3, 4 and 5. A set of standard message types is provided for transmission and reply between the entities of the group to enable the network performance monitor 11 to obtain necessary information.

Figure 4A illustrates a probe message in schematic form

in which the data fields of the message will now be described in general terms. A first field TP represents the type of message, in this case a probe message. A next field IDS represents the identity of the source of the probe message, in this case the terminal 2. Field TSS is a time stamp for the source of the probe message, representing the time at which the probe message is broadcast. Field SNS represents the sequence number of the probe message, being the position of the probe message in a sequence of probe messages originating from the source identified by field IDS.

Figure 4B illustrates a probe reply message which similarly includes a type field TP, a source ID field IDS and a source time stamp TSS. The request probe reply message is issued by the responder 37 when a probe reply message is received. The request probe reply message also includes a response identification field IDR indicating the unique identification of the entity responding to the probe message and a response stamp time field TSR indicating the time stamp of when the response was sent. The message also includes a source sequence number field SNS indicating the sequence number of the probe message to which this probe reply message responds.

By sending a probe message and receiving a probe reply message from each terminal, the local terminal 2 is able therefore to determine from the time stamp fields TSS and TSR the time taken to traverse the network with the probe and probe reply messages. The source sequence numbers also enable the loss detector 36 to keep track of those probe messages which do not elicit a probe reply message, thereby indicating that a packet loss has occurred.

Figure 4C illustrates a request probe reply message which is generated for interrogating a selected one of the terminals in the group when the status provider 34 has identified a particular problem in communicating with that terminal. The message includes type field TP and source ID field IDS as well as a time stamp field TSS, a source sequence number field SNS and a target identification field IDT. The field IDT identifies the terminal to which the message is directed and from which a specific response is requested.

Figure 4D illustrates an announce message which is generated when an entity joins a collaborative group and wishes to announce its inclusion in the system. The announced message comprises type field TP and announce identification field IDA indicating the unique

identification code of the newly joined entity.

Figure 4E illustrates an announce reply message by which terminal 2 responds to the announced message of Figure 4D, the message including TP and IDA fields as well as a reply identification field IDR indicating the identity of the terminal which is responding to the announcement.

Figure 4F illustrates a leave message used to announce that an entity is leaving the collaborative group during the session and consists of type field TP and a leave identification field IDL indicating the unique identification code of the entity leaving the session.

Figure 4G illustrates an alive message consisting of type field TP, source identification field IDS and source sequence number field SNS indicating the current sequence number of the message. This message is used to confirm the continued presence of an entity in the group and to detect packet loss.

From the information received in the probe reply messages, the status provider 34 is able to calculate the time taken to reach each entity and the time taken for the return transmission. This information indicating

network latency local to each entity is then passed to the respective entity state model 30. The loss detector 36 also derives information from the sequence number of probe reply messages concerning packet loss and similarly passes this information to the appropriate entity state model.

For each instance of a response message not being received from one of the entities of the collaborative group, the status provider 34 initiates the output of a request probe reply message targeted specifically to the terminal from which no reply was received. Further information may then be derived from any response received to this specific request.

Figure 5 illustrates schematically the manner in which the output modifier 12 responds to data provided by one of the entity state models 30 which in this example is model 30a. Variable parameters provided by the model 30a are input to an analyser 50 which compares the variables with threshold levels. A decision is taken in accordance with predetermined threshold criteria as to whether action is required to modify the output to the user interface 9. If for example the round trip time for probe transmission and return exceeds a threshold level

of 0.5 seconds, action is triggered whereby an actuator 51 is controlled to interact with the user interface output generator 10. As an example, the user interface output generator 10 comprises a graphics data model 52 which creates graphics data for generating a scene describing a virtual environment, the data being processed by renderer 53 which creates output signals to a display 54. In this example, the actuator 51 interacts with the renderer to cause the breakup of the first character 20 in Figure 2A to result in the fragmented character 23 of Figure 2B, thereby indicating to the user viewing the display that network conditions local to the entity associated with terminal 3 has deteriorated to an extent whereby the integrity of the display of virtual environment is prejudiced. Presented with this breakup of only one of the characters in the virtual environment, the user intuitively appreciates that the display position and other characteristics in the environment associated with this entity should be regarded as being suspect or subject to erratic behaviour during a period in which the breakup continues to be shown. The user may therefore modify the manner in which he interacts with the collaborative group accordingly.

When a new entity joins the group, this is signalled by

the transmission from that entity of an announced message as illustrated in Figure 4D in which the IDA field declares the identity of the new entity. Similarly when an entity leaves the group, this is announced to the remaining entities by the leave message as illustrated in Figure 4F which includes the IDL field declaring the identity of the leaving entity.

As described above, the manager 32 is responsive to such messages to ensure that the correct number of entity state models 30 is provided in the operating environment of the network performance monitor 11 and corresponding analysers 50 and actuators 51 exist in the output modifier 12.

The output modifier 12 may be provided with more than one threshold level for a given state model, for example having first, second and third thresholds against which a given network quality parameter such as latency is compared. Corresponding first, second and third levels of effect may thereby be applied by actuator 51 to provide correspondingly different levels of modification to the display as illustrated in Figure 2A or 2C.

The selection of appropriate form of modification for a

given display may depend on the type of data which is being output for display. For example, both 2D and 3D graphics data are characterised by an alpha-channel which can be variably controlled to change the level of transparency of a constituent character in a scene. For 2-D graphics data systems, it may be more convenient to paint peripheral tiles black, as for example in Figures 2G, 2H and 2I.

For 3-D graphics data systems, it may be more convenient to adjust the intensity as a whole as in Figure 2E since is normal for such data to define a light object in a scene and for the intensity of the light object to be variably controlled.

Other forms of modifier may be appropriate for systems such as video conference systems. An actuator could for example break up video composition of the entire scene to indicate global network problems or break up video composition within one of the number of windows within the display containing video from a particular entity where network problems specifically affecting only that entity have been detected. The video could alternatively be subject to freeze frame or reduced frame size to indicate network degradation. In an audio visual

conference system the audio signal could be modified for example by varying audio volume or applying an audio processing effect such as distortion, frequency shift or any other number of available special effects. Such modifications are examples of qualitative modifications to the information delivered to the user via the user interface. In such audio visual conference systems, the qualitative modifications are used to make the user aware of the state of the network, in contrast to known systems in which various techniques are utilised to mask the state of the network, for example by compensating for degradation in the audio or visual channel.

A number of perceptual metaphors or qualitative modifications may be combined or made selectively available.

In the above described examples, the control of output generation compares a measure of network performance with a number of thresholds. Alternative embodiments are envisaged in which the control of output generation varies in a continuous manner which is not dependent upon any threshold so that for example a perceptual metaphor effect can be varied in intensity in a continuous manner which is determined by a continuously variable parameter

or a function of a number of parameters. Alternatively, control of the output may utilise a hybrid arrangement which is partly triggered by one or more threshold and partly variable in a continuous manner over part of the range of variation of the effect.

In preceding figures, the function of local terminal 2 has been illustrated using a functional block representation. Figure 6 is an example of a hardware representation of a terminal for achieving the above described function. A processor 60 is connected via a bus 61 to network interface 7 and is also provided with read only memory 62 and random access memory 63. A reader 64 allows a storage medium 65 to input program and data code. User interface 10 is also accessible via bus 61.

Processor 60 may be operated to perform the method steps of the present invention in accordance with program code received via storage medium 65 or via a signal communicated via the interface 7, as in the case of program code downloaded over a network such as the internet. The program code provides instructions for controlling the processor 60 to perform steps of a method as summarised in Figure 7. Data from network 6 is

received at step 71 and processed at step 72 to obtain information which is to be presented to the user. The information may be in the form of a virtual environment or communications information, depending upon the application of the collaborative system.

At step 73, output signals are generated for presenting the information via the user interface at step 74.

Network performance is continuously measured at step 75 and at step 76 the output generation step 73 is controlled in dependence upon the information obtained from measuring network performance. Step 76 generally results in a modification to the manner in which the output signals are generated in step 73 in order to indicate to the user the status of the network 6, either globally or specific to one of the collaborative entities, the modification generally resulting in a perceptual metaphor of a displayed scene or a qualitative change in the manner in which the information is presented via the user interface.

Alternative embodiments are envisaged in which user interfaces other than visual displays are utilised and in which appropriate control of output generation is

applied. For example, a user interface may be a haptic interface for presenting stimuli via a touch response, and olfactory interface for presenting stimuli for the user's sense of smell, an audio interface or an interface for delivering stimuli for the user's sense of taste. Combinations of the above interfaces are also envisaged.

The arrangement of Figure 5 may be modified such that multiple actuators exist for a single entity state model and analyser in order to apply multiple superimposed effects to the information displayed to the user.

In the described specific embodiment, the collaborative group comprises a total of four entities. Entities may join or leave the group thereby varying the number of entities so that there is no specific limit on the number of entities to which the embodiments of the present invention have application. Clearly however there must be at least one remote terminal in additional to the local terminal 2 for network performance to have significance. Embodiments are envisaged in which one or more of the terminals is a server providing information utilised by the terminals, as for example in the case of online games played via the Internet.

The disclosed embodiments refer to network parameters of latency and loss. It is envisaged that other network parameters such as jitter (variance of delay) may be utilised for specific collaborative systems and the choice of which parameter (or combination of parameters) is appropriate will depend upon the nature of the network and on the nature of the collaborative task performed by the entities of the collaborative group. In some instances, it may be necessary or appropriate to display to the user more than one network parameter using separately identifiable means of modification to the user interface output.

CLAIMS:

1. A method of operating a local terminal constituting one of a collaborative group of terminals comprising one or more remote terminals communicating with the local terminal via a network, the method comprising operating a computer system of the local terminal to perform the steps of:

receiving data via the network from the remote terminals;

processing the data to obtain information to be presented to a user;

generating an output for presenting the information to the user via a user interface;

determining at least one network performance parameter representative of a respective performance status of the network in facilitating collaborative communication between the terminals; and

controlling the generation of the output in dependence upon the at least one network performance parameter such that the manner in which the information is presented to the user is variable according to the value of the network performance parameter for facilitating user perception of the performance status of the network.

2. A method as claimed in claim 1 wherein the determining step comprises determining respective network performance parameters relating to network conditions specifically effecting each remote terminal of the group of terminals.

3. A method as claimed in claim 2 wherein the generating step generates an output representative of a plurality of objects wherein each object is representative of information obtained from a respective one of the remote terminals and wherein the generating step separately controls the manner in which the output for each object is generated according to the value of a respective network performance parameter specifically affecting the remote terminal associated with that object.

4. A method as claimed in any preceding claim wherein the determining step comprises determining at least one global network performance parameter which is representative of network quality of service affecting the local terminal and thereby affecting communication between the local terminal and all remote terminals of the group.

5. A method as claimed in claim 4 wherein the control step comprises controlling the generation of the output such that the manner in which the information is presented to the user is variable according to the global network performance parameter.

6. A method as claimed in any preceding claim wherein the controlling step comprises controlling the generation of the output such that the variation in network performance parameter is presented using a perceptual metaphor.

7. A method as claimed in any of claims 1 to 5 wherein the controlling step comprises controlling the generation of the output such that the quality of reproduction of the information presented to the user is variable according to the network performance parameter.

8. A method as claimed in any preceding claim wherein the step of determining the network performance parameter comprises measuring network quality of service by transmitting and receiving messages via the network.

9. A method as claimed in claim 8 further comprising the step of monitoring the number of terminals in the

collaborative group and the identities thereof.

10. A method as claimed in claim 2 wherein the step of determining network performance parameters comprises operating a respective model of network conditions for each terminal of the group.

11. A method as claimed in claim 10 wherein the determining step further comprises managing the number of models to correspond in number and identity to respective ones of the terminals active in the group.

12. A method as claimed in any preceding claim wherein the processing step generates graphics data and wherein the controlling step comprises controlling the manner in which the graphics data is rendered.

13. A method as claimed in any preceding claim wherein the controlling step comprises comparing a network performance parameter with one or more thresholds and determining the manner in which the output is varied according to the result of comparison.

14. A method as claimed in any preceding claim wherein the output is generated for displaying a scene to the

user via a user interface.

15. A method as claimed in claim 14 wherein the output is controlled to vary the extent to which an object represented in the display is fragmented.

16. A method as claimed in claim 14 wherein the output is controlled to add ghost images indicating possible positions of a object represented in a scene.

17. A method as claimed in claim 14 wherein the output is controlled to vary the prevailing weather conditions represented in a scene.

18. A method as claimed in claim 14 wherein the output is controlled to vary the overall light level in a scene.

19. A method as claimed in claim 14 wherein the output is controlled to vary a degree of restriction applied by a tunnel effect superimposed on the scene.

20. A method as claimed in claim 14 wherein the output is controlled to vary a magnification applied to the scene.

21. A method as claimed in any preceding claim wherein the processing step comprises generating a distributed virtual environment in which data defining the state of the environment is distributed amongst the terminals of the group and is communicated therebetween via the network.

22. A method as claimed in any of claims 1 to 20 wherein the processing step comprises playing an online game.

23. A method as claimed in any of claims 1 to 20 wherein the processing step comprises processing video data to provide a video conference.

24. Apparatus comprising a local terminal constituting one of a collaborative group of terminals comprising one or more remote terminals communicating with the local terminal via a network, the apparatus comprising a computer system of the local terminal and comprising:

an interface for receiving data via the network from the remote terminals;

processing means for processing the data to obtain information to be presented to a user;

generating means for generating an output for presenting the information to the user via a user

interface;

determining means for determining at least one network performance parameter representative of a respective performance status of the network in facilitating collaborative communication between the terminals; and

control means for controlling the generation of the output in dependence upon the at least one network performance parameter such that the manner in which the information is presented to the user is variable according to the value of the network performance parameter for facilitating user perception of the performance status of the network.

25. Apparatus as claimed in claim 24 wherein the determining means comprises means for determining respective network performance parameters relating to network conditions specifically effecting each remote terminal of the group of terminals.

26. Apparatus as claimed in claim 25 wherein the generating means is operable to generate an output representative of a plurality of objects wherein each object is representative of information obtained from a respective one of the remote terminals and wherein the

generating step separately controls the manner in which the output for each object is generated according to the value of a respective network performance parameter specifically affecting the remote terminal associated with that object.

27. Apparatus as claimed in any of claims 24 to 26 wherein the determining means is operable to determine at least one global network performance parameter which is representative of network quality of service affecting the local terminal and thereby affecting communication between the local terminal and all remote terminals of the group.

28. Apparatus as claimed in claim 27 wherein the control means is operable to control the generation of the output such that the manner in which the information is presented to the user is variable according to the global network performance parameter.

29. Apparatus as claimed in any of claims 24 to 28 wherein the control means is operable to control the generation of the output such that the variation in network performance parameter is presented using a perceptual metaphor.

30. Apparatus claimed in any of claims 24 to 28 wherein the control means is operable to control the generation of the output such that the quality of reproduction of the information presented to the user is variable according to the network performance parameter.

31. Apparatus as claimed in any of claims 24 to 30 wherein the determining means comprises means for measuring network quality of service by transmitting and receiving messages via the network.

32. Apparatus as claimed in claim 31 further comprising means for monitoring the number of terminals in the collaborative group and the identities thereof.

33. Apparatus as claimed in claim 25 wherein the determining means comprises a respective model of network conditions for each terminal of the group.

34. Apparatus as claimed in claim 33 wherein the determining means further comprises means for managing the number of models to correspond in number and identity to respective ones of the terminals active in the group.

35. Apparatus as claimed in any of claims 24 to 34

wherein an output of the processing means comprises graphics data and wherein the control means is operable to control the manner in which the graphics data is rendered.

36. Apparatus as claimed in any of claims 24 to 35 wherein the control means comprises an analyser for comparing a network performance parameter with one or more thresholds and determining the manner in which the output is varied according to the result of comparison.

37. Apparatus as claimed in any of claims 24 to 36 wherein the output comprises signals for use in displaying a scene to the user via a user interface.

38. Apparatus as claimed in claim 37 wherein the control means is operable to control the output to vary the extent to which an object represented in the display is fragmented.

39. Apparatus as claimed in claim 37 wherein the control means is operable to control the output to add ghost images indicating possible positions of a object represented in a scene.

40. Apparatus as claimed in claim 37 wherein the control means is operable to control the output to vary the prevailing weather conditions represented in a scene.

41. Apparatus as claimed in claim 37 wherein the control means is operable to control the output to vary the overall light level in a scene.

42. Apparatus as claimed in claim 37 wherein the control means is operable to control the output to vary a degree of restriction applied by a tunnel effect superimposed on the scene.

43. Apparatus as claimed in claim 37 wherein the control means is operable to control the output to vary a magnification applied to the scene.

44. Apparatus as claimed in any of claims 24 to 43 wherein the processing means is operable to generate a distributed virtual environment in which data defining the state of the environment is distributed amongst the terminals of the group and is communicated therebetween via the network.

45. Apparatus as claimed in any of claims 24 to 43

wherein the processing means is operable for playing an online game.

46. Apparatus as claimed in any of claims 24 to 43 wherein the processing means to operable to process video data to provide a video conference.

47. A storage medium storing processor implementable instructions for instructing a processor to carry out a method as claimed in any one of claims 1 to 23.

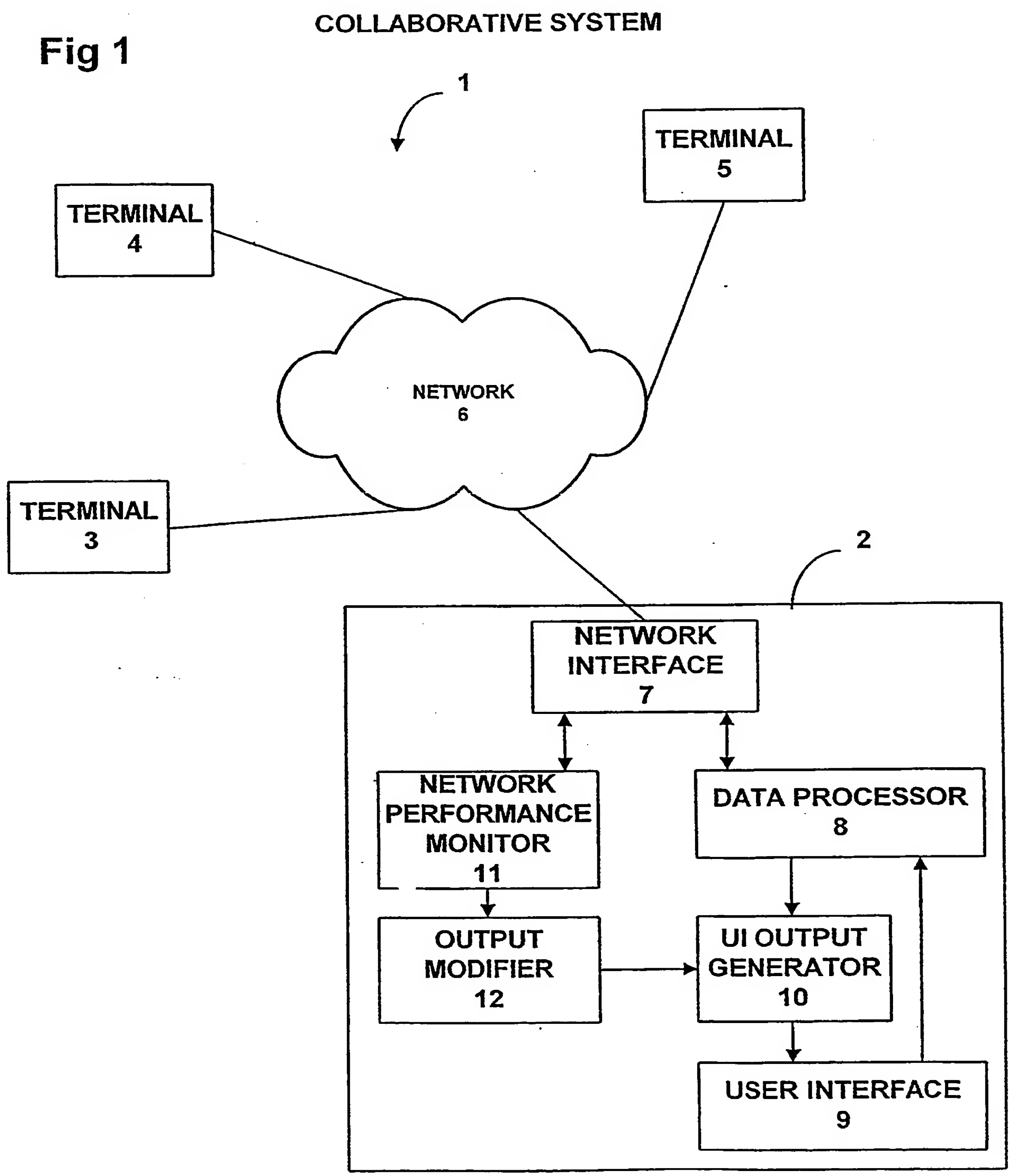
48. A system comprising a collaborative group of terminals communicating via a network, the system comprising:

means for determining the performance status of the network in facilitating collaborative communication between the terminals; and

wherein at least one of the terminals comprises generating means for generating an output for presenting to a user information received via the network and control means for controlling the generation of the output in dependence upon at least one network performance parameter such that the manner in which the information is presented to the user is variable according to the network performance parameter for

facilitating user perception of the performance status of the network.

Fig 1


COLLABORATIVE SYSTEM
1
TERMINAL 5
TERMINAL 4
NETWORK 6
TERMINAL 3
2
NETWORK INTERFACE 7
NETWORK PERFORMANCE MONITOR 11
DATA PROCESSOR 8
OUTPUT MODIFIER 12
UI OUTPUT GENERATOR 10
USER INTERFACE 9

DISPLAY MODIFICATION

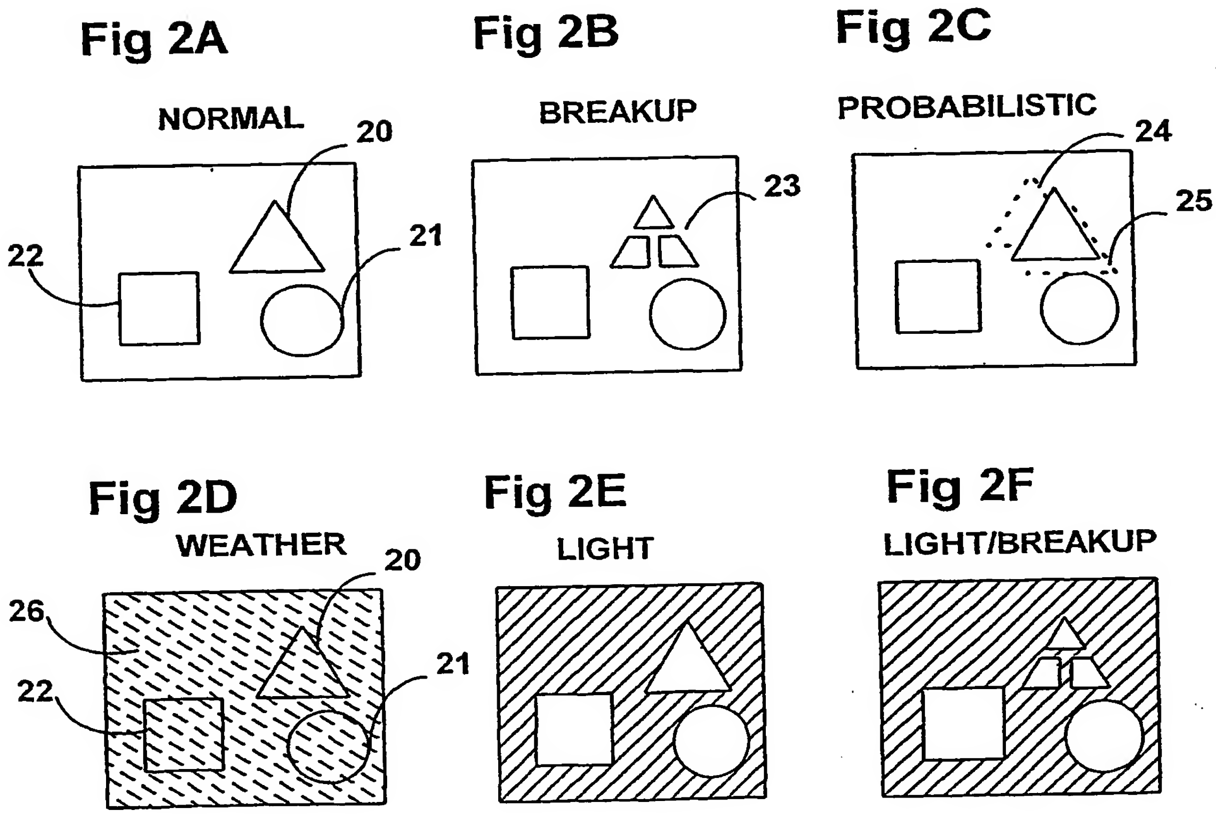


Fig 2G

TUNNEL 1

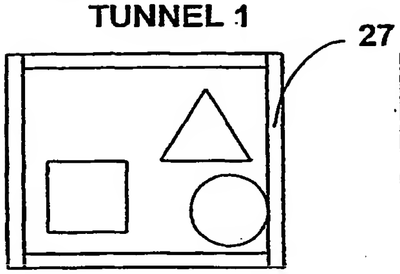


Fig 2H

TUNNEL 2

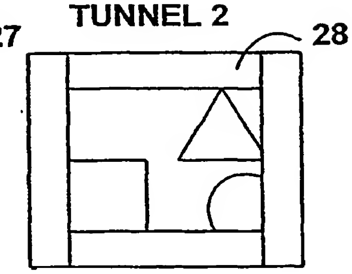


Fig 2I

TUNNEL 3

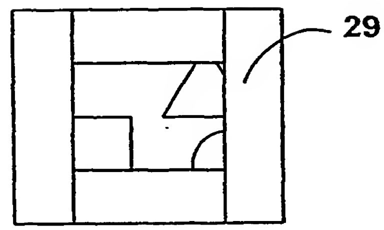


Fig 2J

MAGNIFICATION 1

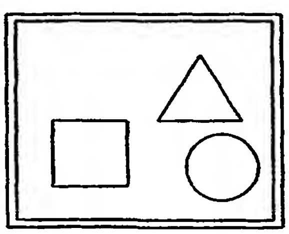


Fig 2K

MAGNIFICATION 2

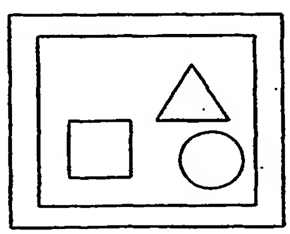


Fig 2L

MAGNIFICATION 3

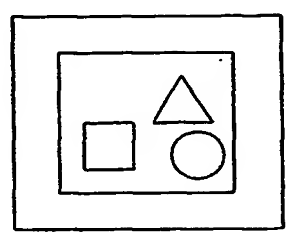


Fig 3

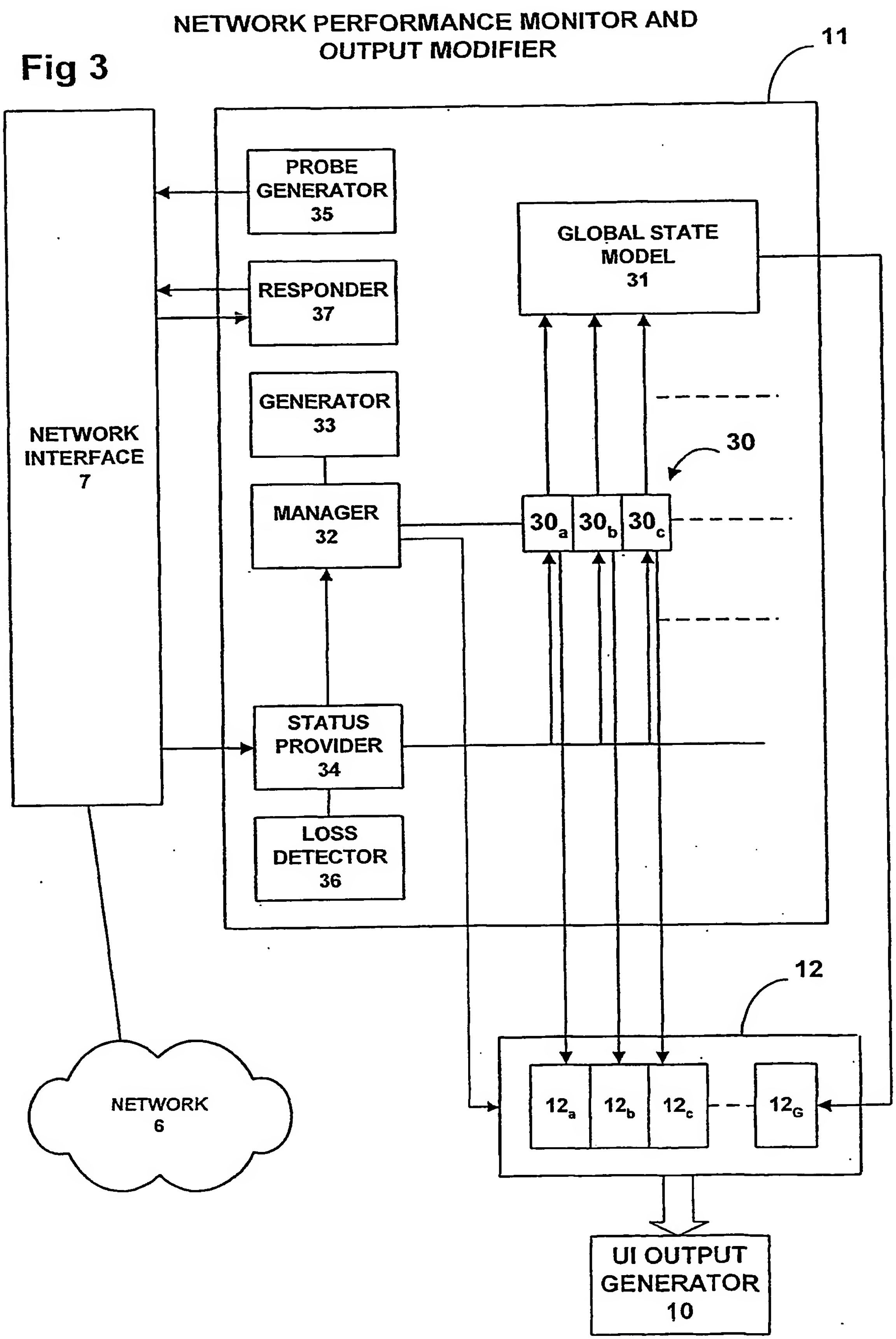

NETWORK PERFORMANCE MONITOR AND OUTPUT MODIFIER
11
PROBE GENERATOR 35
RESPONDER 37
GENERATOR 33
MANAGER 32
STATUS PROVIDER 34
LOSS DETECTOR 36
GLOBAL STATE MODEL 31
30
30_a 30_b 30_c
NETWORK INTERFACE 7
NETWORK 6
12
12_a 12_b 12_c 12_G
UI OUTPUT GENERATOR 10

Fig 4A PROBE MESSAGE

TP	IDS	TSS	SNS

Fig 4B PROBE REPLY MESSAGE

TP	IDS	TSS	IDR	TSR	SNS

Fig 4C REQUEST PROBE REPLY MESSAGE

TP	IDS	TSS	SNS	IDT

Fig 4D ANNOUNCE MESSAGE

TP	IDA

Fig 4E ANNOUNCE REPLY MESSAGE

TP	IDA	IDR

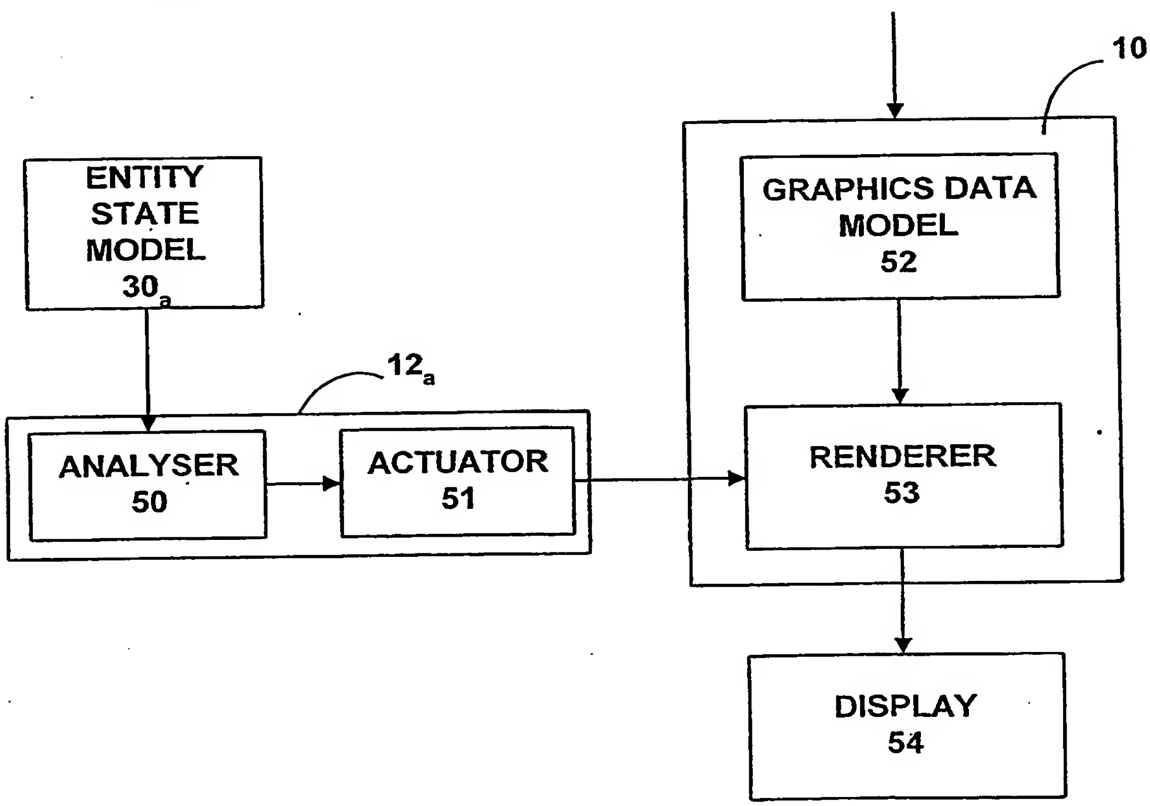
Fig 4F LEAVE MESSAGE

TP	IDL

Fig 4G ALIVE MESSAGE

TP	IDS	SNS

Fig 5


10
ENTITY STATE MODEL 30a
12a
ANALYSER 50
ACTUATOR 51
GRAPHICS DATA MODEL 52
RENDERER 53
DISPLAY 54

TERMINAL HARDWARE

Fig 6

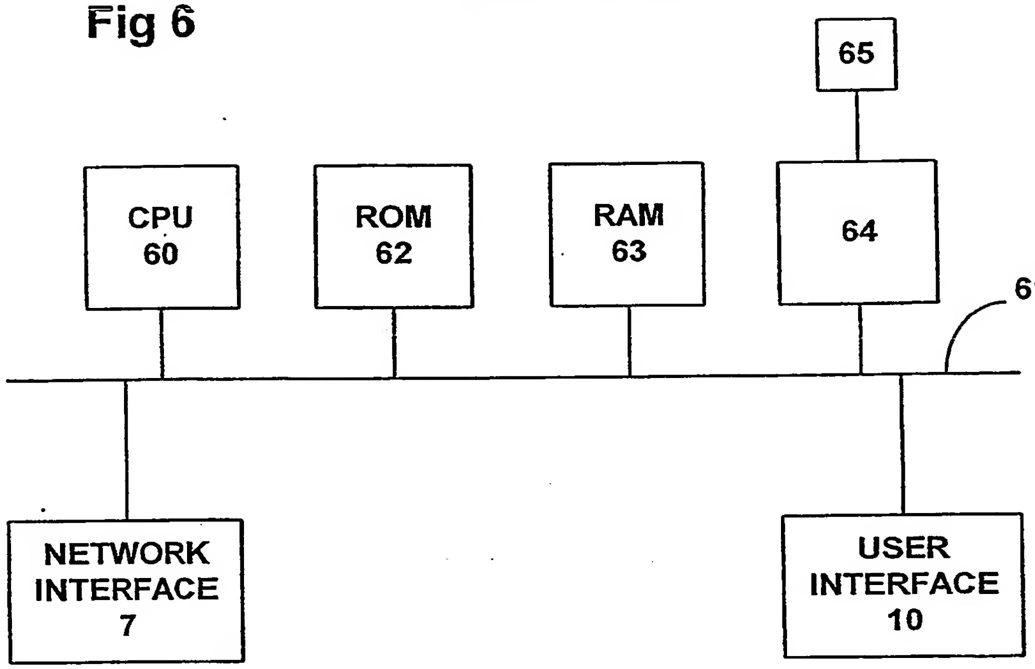
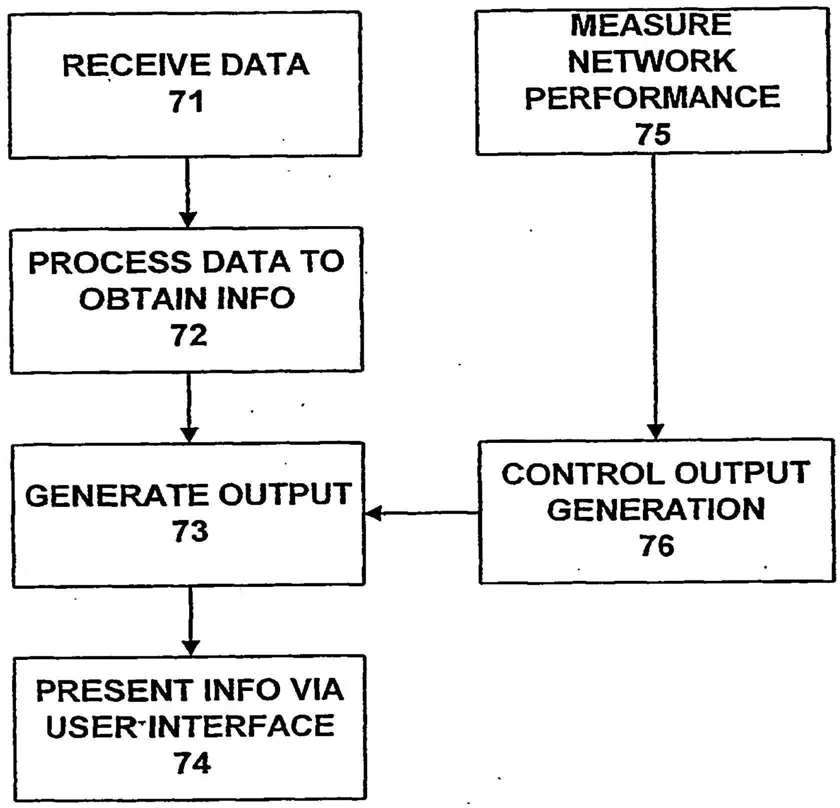


Fig 7


RECEIVE DATA
71
MEASURE NETWORK PERFORMANCE
75
PROCESS DATA TO OBTAIN INFO
72
GENERATE OUTPUT
73
CONTROL OUTPUT GENERATION
76
PRESENT INFO VIA USER INTERFACE
74

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(71) Applicants and
(72) Inventors: **OLIVEIRA, Manuel** [PT/GB]; Flat 3, 3 Park Drive, Golders Green, London, Greater London NW11 7SG (GB). **SLATER, Mel** [GB/GB]; Flat 8, 146 Wapping High St, London, Greater London E1W 3PE (GB). **CROWCROFT, Jon** [GB/GB]; University of Cambridge, William Gates Building, J J Thomson Avenue, Cambridge, Cambridgeshire CB3 0FD (GB).

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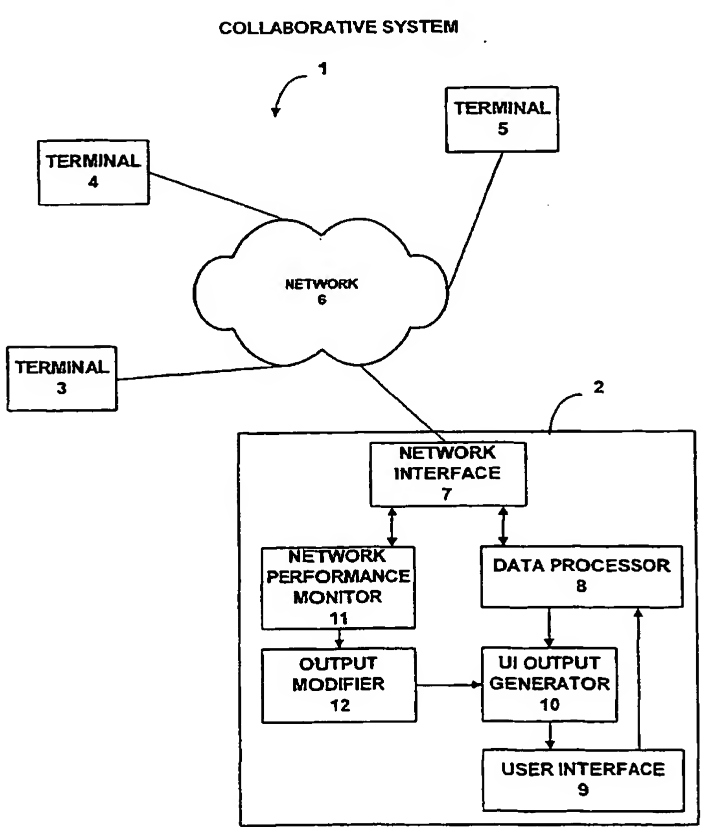
[Continued on next page]

(54) Title: NETWORK PERFORMANCE INDICATORS



(57) Abstract: In a set of local terminals (2-5) communicating via a network (6) to constitute a collaborative system (1), each terminal (2) receives data via the network and processes the data to present information via a user interface (9). A network performance monitor (11) determines a network performance parameter representative of performance status of the network in facilitating collaborative communication between the terminals. The network performance monitor outputs the network performance parameter to an output modifier (12) which controls the output generated by a user interface output generator (10) such that the information presented by the user interface to the user is varied according to the value of the network performance parameter for facilitating user perception of the performance status of the network. Where a scene is presented to the viewer, a perceptual metaphor may thereby be conveyed such as to associate fine sunny weather conditions with a good state of well-being of the network and to associate rainy or wintery conditions with a deteriorating state of well-being of the network. The process has application to virtual reality environments allowing interaction between virtual characters controlled by participants each provided with a respected one of the terminals at remote locations served by the network, as in the case of Internet based games.

WO 2003/097194 A3

Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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- *of inventorship (Rule 4.17(iv)) for US only*

Published:
- *with international search report*
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PCT/GB 03/01135

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A63F13/12 H04L12/26

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04L A63F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 01 03374 A (NORTEL NETWORKS LTD) 11 January 2001 (2001-01-11)	1-3,6,7, 12-14, 24-26, 29,30, 35-37, 47,48
	page 1, line 1 - line 16 page 4, line 18 - line 25 page 5, line 29 - line 32 page 13, line 26 - line 30 page 14, line 4 - line 25 page 15, line 17 - line 20	
Y		4,5,8,9, 22,23, 27,28, 31,32, 45,46

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
9 January 2004	16/01/2004

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Tito Martins, J

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 03/01135

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	figures 1,2	4,5,8,9, 27,28, 31,32
Y	US 6 050 898 A (KOUTS MICHAEL ET AL) 18 April 2000 (2000-04-18) column 3, line 14 - line 20 column 7	4,5,8,9, 22,27, 28,31, 32,45
A	figure 4	1,24,47, 48

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/GB 03/01135

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			CA	2341757	A1	11-01-2001
			EP	1108309	A1	20-06-2001
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			CA	2316355	A1	08-07-1999
			EP	1050128	A1	08-11-2000
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